Abrégé/Abstract: Elevator machinery having a disc-type motor is mounted on one of the guide rails of an elevator car or counterweight. The guide rail adds mechanical strength to the machinery, and vertical forces applied to a traction sheave of the machinery by elevator ropes are passed to the guide rail via a rolling center of a bearing. The elevator machinery has a damping system for absorbing vibrations and oscillations, is light in weight, needs only a small space when mounted, and is inexpensive to manufacture.
ABSTRACT

Elevator machinery having a disc-type motor is mounted on one of the guide rails of an elevator car or counterweight. The guide rail adds mechanical strength to the machinery, and vertical forces applied to a traction sheave of the machinery by elevator ropes are passed to the guide rail via a rolling center of a bearing. The elevator machinery has a damping system for absorbing vibrations and oscillations, is light in weight, needs only a small space when mounted, and is inexpensive to manufacture.
ELEVATOR MACHINERY AND ITS INSTALLATION

The present invention relates to elevator machinery, and more particularly, to machinery in which a motor for moving an elevator is secured to at least one guide rail of the elevator or its counterweight.

5 Depending on the placement of elevator machinery, its physical dimensions have an influence on the size of the elevator shaft and/or building. When the elevator machinery is placed into the elevator shaft, beside the shaft or in a machine room, the properties and dimensions of the machinery have a significance in respect of the space required.

10 Conventional elevator machinery has a motor, a gear system and a traction sheave as separate parts. Such machinery is well-suited for installation in a machine room, because there is a sufficient space reserved for it in the machine room. Solutions are also known in which such machinery is placed into the counterweight or beside the shaft.

15 Elevator machinery can also have a gearless construction, based for example on a disc-type motor as disclosed in Figure 8 of U.S. Patent 5,018,603. The motors disclosed in that specification are clearly more compact and also flatter in the axial direction of the motor shaft than conventional geared elevator machinery. However, the machinery described in the specification is clearly designed for installation in an elevator machine room.

20 When geared or gearless elevator machinery of known construction is placed into the elevator shaft, its space requirement becomes obvious since it always needs extra space.

The object of the present invention is to achieve a new solution for placement of elevator machinery based on a disc-type motor, in which the space required by the machinery when installed in the elevator shaft is as small as possible.

25 According to the present invention, there is provided an elevator machinery for an elevator moving along guide rails, the machinery comprising at least an elevator motor and a traction sheave driving elevator ropes, the elevator motor comprising a discoid stator, a discoid rotor, a motor shaft, and at least one
bearing between the rotor and the stator, whereby the elevator motor is of a flat construction in an axial direction of the motor shaft, and wherein the elevator machinery is fixedly mounted on a longitudinal side of one of the guide rails of the elevator or of its counterweight. The guide rail may be used as a structural part of the elevator machinery. The vertical forces of the elevator ropes on the traction sheave may be passed via a rolling center of the at least one bearing to the guide rail. The elevator machinery may also comprise a supporting element, extending between the elevator machinery and the guide rail, for supporting the elevator machinery on the guide rail. A supporting center of the supporting element may be vertically aligned with the rolling center of the bearing.

The elevator machinery may also have at least one vibration damping element between the elevator machinery and the guide rail, and that element may be positioned between the guide rail and the stator of the elevator motor. The damping element may be attached to the stator and the guide rail via an auxiliary frame in such a manner that the auxiliary frame is attached to the stator and the damping element is positioned between the auxiliary frame and the guide rail. The damping element may be divided into at least three parts defining first, second and third dampers. At least two of those dampers prevent the elevator machinery from substantially turning about the longitudinal axis of the guide rail, and at least two of those dampers prevent the elevator machinery from substantial vertical deviation on the guide rail.

An auxiliary frame may act as a structure to increase the rigidity of the stator. A central part of the frame in the region of the shaft is attached to the stator, and the frame is also attached to the stator at two points on the edge of the stator by means of fixing elements.

The invention provides the advantage that the elevator machinery can be installed in the elevator shaft without substantially requiring any extra space in the shaft. The elevator machinery is mounted on an elevator or counterweight guide rail which necessarily has to be present in the shaft, and the forces in the elevator ropes are thereby transmitted directly to the guide rail. Since the guide rail is designed to receive the large vertical forces generated by the action of the safety gears of the elevator, the dimensions of the guide rails do not need to be analyzed prior to the installation of the machinery.
Elevator machinery of the invention has several advantages. One is that the elevator guide rail is used as a structural part of the elevator machinery to increase its strength. Thus, the elevator machinery itself can have a lighter construction, and is therefore cheaper to manufacture. The vertical forces generated by the elevator ropes are passed via a rolling center of one of the bearings of the machinery to the guide rail. Since the machinery will continue to function even if the guide rail supporting it bends, no reinforcement to increase the rigidity of the rail is required for that part of the guide rail to which the elevator machinery is attached.

The machinery may have means for damping vibrations, placed between the elevator machinery and the guide rail. The damping system in this embodiment ensures that bearing noise and the noise and vibrations generated by the elevator ropes in the rope grooves cannot be transmitted to the guide rail and through it to the building.

The invention is next described with the help of preferred embodiments, in which:

Figure 1 is an end view of a first embodiment of elevator machinery of the invention, the view being along the axis of the motor shaft;

Figure 2 is a cross-sectional side view of the elevator machinery of Figure 1;

Figure 3 is a cross-sectional side view of another embodiment of the elevator machinery;

Figure 4 is a schematic diagram of one layout of the elevator machinery in the elevator shaft;

Figure 5 is a schematic diagram of another layout of the elevator machinery;

Figure 6 is an end view of another embodiment of the elevator machinery, the view illustrating the vibration damping system of the elevator machinery; and,

Figure 7 is a partially-sectioned side view of the elevator machinery of Figure 6.
Figure 1 shows gearless elevator machinery 1 as provided by the invention, mounted on a guide rail 6. The guide rail may be an elevator guide rail or a counterweight guide rail, and the point of attachment of the elevator machinery to the guide rail may be in the upper or lower part of the shaft. The elevator machinery 1 comprises a disc-type elevator motor 2, a brake 3 and a traction sheave 4. The elevator ropes 5 are passed around the traction sheave 4. The elevator machinery is fixed by the edge of the stator 9 to the elevator guide rail 6 by means of clawlike clamps 46 on opposite sides of the machinery. Moreover, a central part of the elevator machinery is fixed to the guide rail by means of fixing elements 35 and a supporting element 34. The vertical forces of the elevator machinery are passed to the supporting element 34 and further via shear bolts 36 to the guide rail 6. The clawlike clamps 46 keep the machinery in place on the guide rail, and prevent it from turning. The fixing elements 35 support the elevator machinery by means of the shear bolts 36 and, together with the supporting element (clamps) 34, prevent the machinery from turning and moving sideways in relation to the guide rail 6. Furthermore, there is a protecting device 33 attached to the guide rail 6 by means of fixing elements 32 to prevent the elevator ropes 5 from coming off the rope groove 19 of the traction sheave 4.

Figure 2 presents the elevator machinery 1 of Figure 1, as sectioned along vertical line A-A. The elevator machinery 1 comprises an elevator motor 2, a traction sheave 4 driving the elevator ropes 5, and a brake 3. The elevator motor 2 consists of a stator 9, a motor shaft 7, a rotor 8, and a bearing 10 between the rotor 8 and stator 9. The stator 9 consists of a stator disc 11 formed by an annular stator core packet 12 with a stator winding 13. The stator core packet 12 together with its winding 13 is attached by means of fixing elements 53 to the stator disc 11. The fixing elements 53 are preferably screws. The rotor 8 consists of a rotor disc 14 provided with rotor excitation elements 15 placed opposite to the stator core packet 12. The rotor excitation elements 15 are formed by attaching a number of permanent magnets 23 to the rotor disc 14 in succession so as to form a ringlike circle. The magnetic flux of
the rotor 8 flows inside the rotor disc 14. The portion of the rotor disc 14 lying under the permanent magnets 23 forms part of the magnetic circuit, and also contributes to the material strength of the rotor 8. The permanent magnets 23 may be different in shape, and they can be divided into smaller magnets placed side-by-side or in succession.

Between the permanent magnets 23 and the stator core packet 12 there is a planar air gap 16 essentially perpendicular to the shaft 7. The air gap 16 may also have a slightly conical shape (not shown in the figure). In this case, the mid-line of the cone coincides with the mid-line 71 of the shaft 7. The traction sheave 4 and the stator 9 are placed on different sides of the rotor disc 14 in the direction of the shaft 7 of the elevator motor 2. The elevator motor 2 may be, for example, a synchronous motor or a commutating d.c. motor.

The traction sheave 4 forms an integrated structure with the rotor disc 14, and the shaft 7 is integrated with the stator disc 11, but both could just as well be implemented as separate parts. However, an integrated structure is preferable, having regard to manufacturing technology. The elevator machinery 1 is mounted on the guide rail 6 by means of a supporting element 34 fixed to the rail with fixing elements (screws) 35. The screws carry the axial (vertical) loads of the elevator machinery. Between the supporting element 34 and the guide rail 6 there are also shear bolts 36 (2 pieces) which receive the vertical loads. The shaft 7 is hollow and the end of the supporting element 34 is inside the hollow shaft. The supporting element 34 has a relatively-narrow annular boss 37 of about 10 mm, placed in alignment with the focus of the rope load of the elevator and at the same time with one of the bearings 10. The elevator machinery 1 is attached to the guide rail 6 by means of clamps 46 holding horizontal supporting elements 45 of stator 9, and by means of supporting element 34 and shear bolts 36 supporting it vertically by its central part and allowing some bending of the guide rail 6 in the region of the narrow boss 37. This arrangement provides the advantage that the guide rail 6 need not be so fixed that it is completely rigid in the region of the elevator machinery 1, but it suffices for the retention of the guide rail 6 to fix it to the elevator shaft by
means of supporting elements 40 placed on opposite sides of the elevator machinery 1 (Figure 1). The guide rail 6 still functions as a structural part reinforcing the elevator machinery 1. Therefore, the stator 9 of the elevator machinery 1 can be of a light construction, providing an economic advantage.

The stator disc 11 is provided with a cuplike or ring-shaped troughlike cavity 20 formed by a first wall 21 and a second wall 22 joined together, leaving the cavity open on one side. The first wall 21 is attached to the shaft 7. The stator core packet 12 with the stator winding 13 is attached to the first wall by means of fixing elements 53. The second wall 22 is directed towards the rotor disc 14.

The elevator machinery 1 of the invention can also be implemented as an embodiment having a stator disc 11 having a cuplike or ring-shaped annular cavity 20 open on one side and formed by a first wall 21 and a second wall 22 joined together, both walls being directed towards the rotor disc 14. The first wall 21 is attached to the shaft 7 by means of bracing ribs, and the stator core packet 12 with the stator winding 13 is attached either to the first or the second wall. This second embodiment is suited for elevator motors having a very large diameter. The structure is not shown in the figures because the above description is sufficient for a person skilled in the art.

Mounted between the rotor disc 14 and the second wall 22, and directed towards the rotor disc 14, is a sealing 24, which may be a felt gasket, a lap seal or some other type of sealing, for example, a labyrinth seal. The labyrinth seal may be implemented, for example, by providing the rotor disc 14 with a first ridge in the zone of sealing 24, and providing the stator disc 11 with collet-shaped ridges in a corresponding location on either side of the first ridge. The sealing 24 prevents detrimental particles from getting into the cavity 20.

The rotor disc 14 is provided with a brake disc 38 for a disc brake, forming an extension of the outer circle of the rotor disc 14. The brake 3 may also be a shoe brake, in which case the braking surface is the outermost part 39 of the annular brake disc. Thus, the brake disc is substantially an immediate extension of the rotor disc 14, yet with a narrow annular area for a sealing
between the rotor bars and the brake disc. Elevator machinery 1 also has an outermost wall 45, which extends over the brake disc and forms a baffle plate shielding the brake plate from being touched.

Placed between the elevator machinery 1 and the guide rail 6 is a damping means for damping vibrations. The figures do not show the damping means, but it is implemented by placing an element made of a damping material such as rubber between the clamps 46 and the guide rail 6. A corresponding vibration damping element, preferably a tubular one, is also provided between the supporting element 34 and the shaft 7 of the elevator machinery 1.

Figure 3 presents horizontal section B-B of Figure 1. The elevator machinery 1 has two brakes 3 float-mounted by means of fixtures 42 and 43, which extend between mounting brackets 47 (forming an extension of the stator disc 11) and a bar 41 attached to the stator disc 11. The braking surfaces 44 of the brake are placed on either side of the brake disc. The figure also shows the projections 48, placed on opposite sides of the stator disc 11 in the direction of the guide rail 6 and directed towards the guide rail 6, by which the elevator machinery 1 is fastened to the guide rail 6 by means of fixing elements 49.

Figures 4 and 5 present diagrams giving two examples of the placement of the elevator machinery 1 of the invention on a guide rail 6 in an elevator shaft 51.

In Figure 4, the elevator machinery 1 is fixed to the top end of the guide rail 6 in the manner illustrated by Figure 1. The guide rail 6 may be either an elevator guide rail or a counterweight guide rail. One end of the elevator rope 5 is attached to the top 52 of the elevator shaft 51 at point 50, from where the elevator rope is passed via diverting pulleys 56 below the elevator car 54 and up to the traction sheave 4 of the elevator machinery 1. From there it is further passed down to the diverting pulley 57 of the counterweight 55 and then back up to point 58 at the top 52 of the shaft, to which the other end of the elevator rope 5 is fixed.

Figure 5 illustrates another solution, in which the elevator machinery 1 is fixed to the lower end of the guide rail 6 in the elevator shaft 51.
One end of the elevator rope 5 is attached to the top 52 of the elevator shaft 51 at point 50. From there the rope 5 is passed down via diverting pulleys 56 below the elevator car 54 and then over a diverting pulley 59 in the top part of the shaft 51, and then back down to the traction sheave 4 of the elevator machinery 1 fixed to the lower end of the guide rail 6. From there the rope is passed back up to another diverting pulley 60, then downwards to the diverting pulley 57 of the counterweight 55, and then back up to point 58 at the top of the elevator shaft 51, to which the other end of the elevator rope 5 is fixed.

Figures 6 and 7 present an application of the vibration damping system in elevator machinery 1 of the invention, the machinery 1 being mounted on the guide rail 6 by means of an auxiliary frame 64.

The auxiliary frame 64 consists of a base plate 66, two side plates 65, a top end plate 67 and a bottom end plate 68, said plates being joined together. The side plates 65 are reinforcing plates extending through about one-half of the rail height past the T-back towards the guide surface. This solution achieves a small total thickness for the elevator machinery 1. The vibration damping elements 61, 62 and 63 between the elevator machinery 1 and the guide rail 6 are attached to the stator 9 and the guide rail 6 via the auxiliary frame 64 in such manner that the auxiliary frame 64 is fixed to the stator 9, and the damping elements 61, 62 and 63 are between the guide rail 6 and the auxiliary frame 64. In principle, it would be possible to use only one damping element, but technically and economically it is advantageous to divide a damping element into smaller parts, preferably three parts, a first damper 61, a second damper 62, and a third damper 63. The dampers 62 and 63 prevent the elevator machinery 1 from substantially turning about the longitudinal axis of the guide rail 6. Similarly, the first damper 61 and either the second damper 62 or the third damper 63 prevent the elevator machinery 1 from substantial vertical deviation on the guide rail 6. The first damper 61 at the top edge of the elevator machinery 1 is held between the top end plate 67 and a top cover 69, said top cover 69 being attached to the guide rail 6 by means of a fixing element 73. Correspondingly, the second damper 62 and third damper 63,
positioned side-by-side below the elevator machinery 1, are held between the auxiliary frame 64 and a lower supporter 70. The lower supporter 70 is attached to the guide rail 6 by means of fixing elements 74. The top cover 69 and the lower supporter 70 are provided with a fillet to prevent sideways movement of the dampers. The shear forces resisting the rotation and rolling over of the elevator machinery 1 are transmitted by guide pins 72, fixed to the auxiliary frame 64 and passing through the dampers. The auxiliary frame 64 also acts as a structural part increasing the rigidity of the stator 9, a central part of the auxiliary frame 64 being attached to the stator 9 in the region of the shaft 7 by means of the supporting element 34 and fixing elements 35. The auxiliary frame 64 is also attached to stator 9 at two points on the edge of the stator 9 by means of fixing elements 77. One of the hoisting lugs 76 of the elevator machinery 1 is attached to the guide pin 72 going through the first damper 61. The guide pins 72 are passed through holes 75 in the top and bottom end plates. The guide pins 72 act as safety devices after the possible occurrence of damper breakage, since in that case the guide pin 72 remains leaning against the top or bottom end plate.

An alternative way of mounting the dampers is to place each damper between two cuplike structures. The upper cup would have a diameter slightly larger than that of the lower cup, and would partly surround the lower cup. In the event of damper breakage, the cup edges come into contact with each other, thus preventing the elevator machinery 1 from coming off the auxiliary frame 64.

It should be obvious to a person skilled in the art that different embodiments of the invention are not restricted to the examples described above, but that they may instead be varied within the scope of the claims presented below.
THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. Elevator machinery for an elevator moving along guide rails, said machinery comprising at least an elevator motor and a traction sheave driving elevator ropes, said elevator motor comprising a discoid stator, a discoid rotor, a motor shaft, and at least one bearing between the rotor and the stator, whereby the elevator motor is of a flat construction in an axial direction of the motor shaft, and wherein the elevator machinery is fixedly mounted on a longitudinal side of one of the guide rails of the elevator or of its counterweight.

2. Elevator machinery as in claim 1, wherein the one of the guide rails is used as a structural part of the elevator machinery.

3. Elevator machinery as in claim 1, wherein the vertical forces of the elevator ropes on the traction sheave are passed via a rolling center of the at least one bearing to the one of the guide rails.

4. Elevator machinery as in claim 2, wherein the vertical forces of the elevator ropes on the traction sheave are passed via a rolling center of the at least one bearing to the one of the guide rails.

5. Elevator machinery as in any one of claims 1 to 4, and also comprising a supporting element extending between the elevator machinery and the one of the guide rails for supporting the elevator machinery on the guide rail.

6. Elevator machinery as in any one of claims 1 to 4, and also comprising a supporting element extending between the elevator machinery and the one of the guide rails for supporting the machinery on the guide rail, wherein a supporting center of the supporting element is vertically aligned with the rolling center of the bearing.
7. Elevator machinery as in any one of claims 1 to 4, and also comprising a supporting element extending between the elevator machinery and the one of the guide rails for supporting the machinery on the guide rail, wherein a supporting center of the supporting element is vertically aligned with the rolling center of the bearing, and wherein there is at least one vibration damping element between the elevator machinery and the guide rail.

8. Elevator machinery as in any one of claims 1 to 4, and also comprising a supporting element extending between the elevator machinery and the one of the guide rails for supporting the machinery on the guide rail, wherein a supporting center of the supporting element is vertically aligned with the rolling center of the bearing, and wherein there is at least one vibration damping element between the elevator machinery and the guide rail, the damping element being positioned between the guide rail and the stator of the elevator motor.

9. Elevator machinery as defined in claim 1, and also comprising at least one vibration damping element positioned between the elevator machinery and the one of the guide rails, wherein the damping element is attached to the stator and the guide rail via an auxiliary frame in such a manner that the auxiliary frame is attached to the stator and the damping element is positioned between the auxiliary frame and the guide rail.

10. Elevator machinery as defined in claim 9, wherein the damping element is divided into at least three parts defining first, second and third damping elements, wherein at least two damping elements prevent the elevator machinery from substantially turning about the longitudinal axis of the guide rail, and wherein at least two of those damping elements prevent the elevator machinery from substantial vertical deviation on the guide rail.

11. Elevator machinery as defined in claim 9, wherein the auxiliary frame acts as a structure increasing the rigidity of the stator, a central
part of the auxiliary frame in the region of the shaft being attached to the stator, the auxiliary frame also being attached to the stator at two points on the edge of the stator by means of fixing elements.

12. Elevator machinery as defined in claim 10, wherein the auxiliary frame acts as a structure increasing the rigidity of the stator, a central part of the auxiliary frame in the region of the shaft being attached to the stator, the auxiliary frame also being attached to the stator at two points on the edge of the stator by means of fixing elements.